

1                   **METHOD FOR FABRICATING HIGH DENSITY OF**  
2                   **MULTI-POLYIMIDE-LAYER DPC LINES ON A CERAMIC BOARD**  
3                   BACKGROUND OF THE INVENTION

4                   1. Field of the Invention

5                 The present invention relates to a method for fabricating high density of  
6                 multi-polyimide-layer directly plated copper (DPC) lines on a ceramic board and  
7                 more particularly to the method providing high density of the lines on the ceramic  
8                 board.

9                   2. Description of Related Art

10               Surface Mounted Technology (SMT) has resulted in advances in  
11               miniaturization of electronics and this is a key to make the electronic products to  
12               become increasingly smaller than normal. However, while designing the  
13               electronic elements to be miniaturized, some problems have occurred in this  
14               miniaturization technology, such as how to design a high density of an integrated  
15               circuit in a limited area of a chip and how to dissipate heat from an operating chip.  
16               Of particular concern is the quantity of inductors included in a line of the  
17               integrated circuit when that circuit is adapted to the Radio Frequency (RF) circuit.  
18               Because the quantity of inductors of each line is increased as the RF circuit  
19               applies a higher frequency, and the quantity of the inductors causes the RF circuit  
20               to have abnormal functions during operating.

21               In a DPC process for fabricating a ceramic chip, the conductive through  
22               holes define in the ceramic board to electronically interconnect the circuits  
23               formed on the upper and bottom face of the ceramic board. The conductive  
24               through holes in a ceramic board by using a drilling machine and then the inner

1 surface of the through holes are plated with copper, that is each of through holes is  
2 not stuffed all the conductive copper. Because the drilling machine is not able to  
3 cut very fine holes required in miniaturization, the total area of the through holes  
4 takes up considerable space of the ceramic board. On the other hand, the density  
5 of the integrated circuit on the board does not increase.

6 To overcome those shortcomings, the present invention provides simple  
7 and easy steps and good production ability to mitigate and obviate the  
8 aforementioned problems.

9 SUMMARY OF THE INVENTION

10 The main objective of the present invention is to provide an effective  
11 method for increasing the density of the integration of the metal lines on a limited  
12 space of a ceramic board. Besides, controlling the low quantity of the inductor of  
13 a metal line ensures the RF circuit in a normal function state. The method for  
14 fabricating the DPC lines comprises the following steps:

15 defining fine through holes in the ceramic board by using laser beams or a  
16 photolithography technology;

17 forming first conductive pillars in the fine through holes;

18 forming first metal lines on an upper surface and a bottom surface of the  
19 ceramic board, wherein the conductive pillars connect with the first metal lines in  
20 the upper surface and a bottom surface;

21 applying insulating layers on the two surfaces of the ceramic board, the  
22 insulating layer covers the bottom surface and the first metal lines, and then  
23 columns corresponded to the first metal lines define in a portion of the insulating  
24 layer; and

1 forming second metal lines in the insulating layer, the columns connect  
2 the second metal line with the first metal lines.

3 Therefore, fabricating the high density of metal lines on the ceramic  
4 board is easy by the fine through holes and the insulating layers. Besides the  
5 conductive pillars are stuffed in the fine through holes, the quantity of inductors  
6 effectively decreases. That is, the power loss of the metal lines is low.

7 The other objective of the present invention is to provide an effective  
8 method for dissipating heat from an operating metal lines by using the ceramic  
9 board and the polyimide insulating layers.

10 Other objects, advantages, and novel features of the invention will  
11 become more apparent from the following detailed description when taken in  
12 conjunction with the accompanying drawings.

13 **BRIEF DESCRIPTION OF THE DRAWINGS**

14 Fig. 1 is a flow of a method in accordance with the present invention  
15 explaining the steps of the method;

16 Figs. 2A and 2B are cross sectional views of making a conductive pillar  
17 on a ceramic board step of the method in accordance with the present invention;

18 Fig. 2C is cross sectional view of forming first metal lines on an upper  
19 and bottom surfaces of the ceramic board step of the method in accordance with  
20 the present invention;

21 Fig. 2D is cross sectional view of forming an insulating layer on the upper  
22 and bottom surfaces of the ceramic board step of the method in accordance with  
23 the present invention; and

24 Fig. 2E is cross sectional view of forming second metal lines on the

1 insulating layer step of the method in accordance with the present invention.

2 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

3 With reference to Figs. 1 and 2A to 2E, the method for fabricating a high  
4 density of multi-layer DPC lines on a ceramic board comprises the following  
5 steps:

6 defining through holes (11) in a portion of the ceramic board (10) by a  
7 photolithography technology or laser beams as shown in Fig. 2A;

8 forming a conductive pillar (12) in each of the through holes (11), that is,  
9 a conductive material is put in the through hole to (11) become the first  
10 conductive pillar (12), as shown in Fig. 2A;

11 forming first metal lines (13)(14) on an upper surface and a bottom  
12 surface of the ceramic board (10), wherein the conductive pillar (12) connects  
13 with the first metal lines (13)(14) formed on the upper surface and bottom surface  
14 of the ceramic board (10);

15 applying an insulating layer (15) (16) on the upper surface and the bottom  
16 surface of the ceramic board (10) to cover the upper surface and the bottom  
17 surface of the ceramic board (10) and the first metal lines (13)(14), and then  
18 columns (151) (161) corresponded to the first metal lines(13)(14) respectively  
19 define on the insulating layer (15)(16), wherein the material of the insulating  
20 layer (15)(16) is a polyimide, as shown in Fig. 2D; and

21 forming second metal lines (17)(18) in the insulating layer (15)(16),  
22 wherein when using the conductive material, such as titanium or copper, to form  
23 the second metal lines, and the columns (151)(161) for electronically connecting  
24 the second metal lines (17)(18) with the first metal lines (13)(14), as shown in Fig.

1 2E.

2 The invention provides a multi-polyimide layer on the ceramic board by  
3 insulating layers, that is more metal lines form on each of the polyimide layer. To  
4 fabricate the ceramic board with the multi-polyimide layer is easy that the  
5 previous two steps, ie, forming the insulating layer step and forming the second  
6 metal lines step. Meanwhile, an electronically connecting step is performed after  
7 the each applying insulating layer step to connect the two metal lines in different  
8 insulating layers. For example the column (151) is defined on the insulating layer  
9 (15) to connect with the first metal lines and the second metal lines (17) separated  
10 by the insulating layer (15).

11 Because the ceramic board has special characteristics, such as a low  
12 power loss and great effective dispersing heat performance, and the fine through  
13 holes are defined by the photolithography technology or the laser beams.  
14 Therefore, the total size of the through holes does not occupy considerable space  
15 of the ceramic board, and thus the density of the integration of the metal lines is  
16 accordingly large. Besides, using the insulating layers on the surfaces of the  
17 ceramic board is able to increase the space where metal lines formed, so that the  
18 density of the integration of the metal lines is increased.

19 According to the above description about the invention, the method  
20 provides a high integration of lines on the ceramic board via the fine through  
21 holes and the insulating material, especially the ceramic board with high  
22 integration of the integrated circuit adapted to apply on the RF circuit. Meanwhile  
23 the conductive pillars and conductive columns fill in the fine through holes, so  
24 that the quantity of the inductors of the conductive pillars and conductive

1   columns are fewer than the inductors of the conventional conductive holes made  
2   by the drilling machine and the electroplate technology.

3           Although the present invention has been explained in relation to its  
4   preferred embodiment, it is to be understood that many other possible  
5   modifications and variations can be made without departing from the spirit and  
6   scope of the invention as hereinafter claimed.